Claims

1. An encapsulated electrophoretic element comprising a plurality of non-spherical capsules disposed substantially in a single layer on a substrate.

2. The element of claim 1 wherein the capsules are of substantially uniform size.

3. The element of claim 1 wherein the capsules are substantially planar on at least one side proximate the substrate.

4. The element of claim 1 wherein the plurality of capsules are disposed on the substrate and are in association with a binder, thereby to form a film.

5. The element of claim 4 wherein the film comprises closely-packed capsules.

6. The element of claim 4 wherein the binder comprises a binder solid and wherein a ratio of a mass of the binder solid to a mass of the capsules of at least a portion of the element is from about 1:2 to about 1:20.

7. The element of claim 4 wherein at least a portion of the element has an optically active fraction of at least 70%.

8. The element of claim 4 further comprising a layer of material substantially filling any interstices formed within the film.

9. The element of claim 8 wherein the layer of material is substantially planar on a side opposite the film.

10. The element of claim 8 wherein the capsules, the binder, and the layer of material comprise a stratum having a substantially uniform thickness.

11. The element of claim 10 wherein the stratum has a thickness of about 10 μm to about 500 μm.

12. The element of claim 8 wherein the layer of material comprises the binder.

13. The element of claim 8 wherein the layer of material comprises an insulator.

14. The element of claim 8 wherein the layer of material is tacky during at least one of prior to, during, and after substantially filling the interstices within the film.

15. The element of claim 8 wherein the layer of material is in a liquid state during at least one of prior to, during, and after substantially filling the interstices within the film.

16. The element of claim 8 wherein the capsules, the binder, and the layer of material comprise a stratum that is substantially free from voids.

17. The element of claim 8 wherein the layer of material has a thickness of less than or equal to about 50 μm.

18. The element of claim 8 wherein the layer of material comprises a conductor.

19. The element of claim 8 wherein the layer of material comprises a semiconductor.

20. The element of claim 8 wherein the layer of material comprises an adhesive containing a material selected from the group consisting of carbon particles, gold particles, aluminum particles, platinum particles, silver particles, plated polymer spheres, plated glass spheres, and indium tin oxide particles.

21. The element of claim 8 wherein the layer of material comprises an adhesive containing a material selected from the group consisting of polyacetylene, polyaniline, polypyrrole, polyethylene dioxythiophene, and polythiophene.

22. The element of claim 8 further comprising a rear substrate disposed adjacent the layer of material.

23. The element of claim 22 wherein the layer of material is initially associated with the film.

24 The element of claim 22 wherein the layer of material is initially associated with the rear substrate.

25. The element of claim 22 wherein the rear substrate comprises a material selected from the group consisting of a polymeric material, a glass, and a metal.

26. The element of claim 22 wherein the rear substrate comprises at least one electrode.

27. The element of claim 22 wherein the rear substrate comprises at least one transistor.

28. The element of claim 27 wherein the transistor comprises a silicon-based material.

29. The element of claim 27 wherein the transistor comprises an organic material.

30. The element of claim 22 wherein the rear substrate comprises at least one diode.

31. The element of claim 1 wherein the substrate comprises a polymeric material.

32. The element of claim 1 wherein the substrate comprises at least one electrode.

33. The element of claim 32 wherein the electrode comprises indium tin oxide.

34. The element of claim 1 wherein the substrate comprises a polyester film.

35. The element of claim 1 wherein the substrate has a thickness of about 25 μm to about 500 μm.

36. The element of a claim 1 wherein each capsule is defined by a respective capsule wall having a thickness from about 0.2 μm to about 10 μm.

37. The element of claim 1 wherein the capsules comprise a polymer matrix having fluid-containing cavities.

38. The element of claim 1 wherein at least one of the capsules includes a suspending fluid and at least one species of particle.

39. The element of claim 1 wherein at least one of the capsules includes at least two species of electrophoretic particles, wherein an optical property of a first species of particle is different from a second species of particle.

40. An encapsulated electrophoretic display comprising at least one element, the element comprising a plurality of non-spherical capsules disposed substantially in a single layer on a substrate.

41. A process for creating an encapsulated electrophoretic element that is capable of having a plurality of capsules disposed on a substrate in substantially a single layer, the process comprising the steps of:

(a) providing the capsules;

(b) mixing at least one of the capsules with a binder to create a capsule/binder mixture;

(c) coating the capsule/binder mixture onto an at least partially conductive substrate, thereby to create a film; and

(d) curing the capsule/binder mixture.

42. The process of claim 41 wherein the binder is selected from the group consisting of acrylic, urethane, and poly(vinyl alcohol).

43. The process of claim 41 wherein the binder comprises a polymer latex.

44. The process of claim 41 wherein a fraction of the binder is capable of evaporating.

45. The process of claim 41 wherein the substrate comprises an indium tin oxide sputtered polyester film.

46. The process of claim 41 wherein at least one of the capsules contains a plurality of particles dispersed in a suspending fluid.

47. The process of claim 46 wherein the particles comprise titanium dioxide.

48. The process of claim 46 wherein the suspending fluid comprises a halogenated hydrocarbon.

49. The process of claim 46 wherein the suspending fluid comprises an aliphatic hydrocarbon.

50. The process of claim 41 wherein the coating step comprises applying pressurized gas to the capsule/binder mixture, thereby to cause deposition of the capsule/binder mixture onto the substrate such that the capsules are disposed on the substrate in substantially a single layer.

51. The process of claim 50 further comprising heating the pressurized gas to a temperature higher than an ambient temperature prior to applying the pressurized gas to the capsule/binder mixture.

52. The process of claim 50 further comprising cooling the pressurized gas to a temperature lower than an ambient temperature prior to applying the pressurized gas to the capsule/binder mixture.

53. The process of claim 50 further comprising adding a liquid to the pressurized gas.

54. The process of claim 53 wherein the liquid comprises at least one droplet.

55. The process of claim 53 wherein the liquid comprises an organic solvent.

56. The process of claim 55 wherein the organic solvent comprises an alcohol.

57. The process of claim 50 wherein the coating step comprises applying the pressurized gas with an air knife.

58. The process of claim 50 wherein the pressurized gas is applied from a distance of about 1 cm to about 15 cm from the surface of the capsule/binder mixture.

59. The process of claim 50 wherein the pressurized gas is applied at an angle of from 0 degrees to 90 degrees from the surface of the conductive substrate.

60. The process of claim 50 wherein the pressurized gas comprises air.

61. The process of claim 56 wherein the alcohol comprises a compound selected from the group consisting of isopropyl alcohol, methanol, and ethanol.

62. The process of claim 55 wherein the organic solvent comprises a compound selected from the group consisting of butyl acetate, methylene chloride, and chlorobenzene.

63. The process of claim 41 wherein the coating step comprises coating at least some of the capsules onto the substrate through a coating head.

64. The process of claim 63 wherein at least some of the capsules are dispensed through the coating head with a pump.

65. The process of claim 64 wherein the pump provides pumping pressure with a low shear force.

66. The process of claim 63 wherein the coating head comprises a slot die coating head.

67. The process of claim 66 wherein a width of a slot of the slot die coating head is between about 1 and about 2.5 times the mean diameter of the capsules.

68. The process of claim 63 wherein at least some of the capsules are disposed in and form a single layer.

69. The process of claim 41 further comprising laminating the film with a rear substrate.

70. The process of claim 69 wherein a layer of material is disposed between the film and the rear substrate.

71. The process of claim 70 wherein the layer of material is associated with the rear substrate prior to laminating.

72. The process of claim 70 wherein the layer of material is associated with the film prior to laminating.

73. The process of claim 69 wherein heating occurs during the step of laminating.

74. The process of claim 69 wherein pressurizing occurs during the step of laminating.

75. The process of claim 69 wherein evacuating of a gas occurs during the step of laminating.

76. The process of claim 70 wherein the layer of material comprises an insulator.

77. The process of claim 70 wherein the layer of material comprises a conductor.

78. The process of claim 70 wherein the layer of material comprises a semiconductor.

79. The process of claim 70 wherein the layer of material is in a liquid state during at least a portion of the laminating step.

80. The process of claim 70 wherein the layer of material comprises the binder.

81. The process of claim 70 wherein the step of laminating produces a stratum comprising the capsules, the binder, and the layer of material and having at least one substantially planar side proximate the rear substrate.

82. The process of claim 70 wherein the step of laminating produces a stratum comprising the capsules, the binder, and the layer of material, the stratum being substantially free from voids.

83. The process of claim 70 wherein the layer of material has a thickness of less than or equal to about 50 μm.

84. The process of claim 70 wherein the step of laminating produces a stratum comprising capsules, the binder, and a the layer of material, the stratum having a substantially uniform thickness.

85. The process of claim 70 wherein the layer of material is tacky during at least one of prior to, during, and after substantially filling the interstices within the film.

86. The process of claim 70 wherein the layer of material comprises an adhesive containing a material selected from the group consisting of carbon particles, gold particles, aluminum

particles, platinum particles, silver particles, plated polymer spheres, plated glass spheres, and indium tin oxide particles.

87. The process of claim 70 wherein the layer of material comprises an adhesive containing a material selected from the group consisting of polyacetylene, polyaniline, polypyrrole, polyethylene dioxythiophene, and polythiophene.

88. The process of claim 70 wherein the layer of material substantially fills any interstices formed within the film.

89. The process of claim 41 wherein the binder comprises a binder solid and wherein a ratio of a mass of the binder solid to a mass of the capsules of at least a portion of the element is from about 1:2 to about 1:20.

90. The process of claim 41 further comprising the step of removing water from association with at least some of the capsules.

91. The process of claim 90 wherein the step of removing water comprises a process selected from the group consisting of centrifuging, absorbing, evaporating, mesh filtrating and osmotic separating.

92. An encapsulated electrophoretic element comprising a plurality of capsules disposed substantially in a single layer on a substrate and in association with a binder, thereby to form a film, wherein the binder comprises a binder solid and wherein a ratio of a mass of the binder solid to a mass of the capsules of at least a portion of the element is from about 1:2 to about 1:20.

93. An encapsulated electrophoretic element comprising a plurality capsules disposed substantially in a single layer on a substrate and associated with a binder, thereby to form a film, wherein at least a portion of the element has an optically active fraction of at least 70%.

94. An encapsulated electrophoretic display comprising at least one element, the element comprising a plurality of capsules disposed substantially in a single layer on a substrate and in association with a binder, thereby to form a film, wherein the binder comprises a binder solid and wherein a ratio of a mass of the binder solid to a mass of the capsules of at least a portion of the element is from about 1:2 to about 1:20.

95. An encapsulated electrophoretic display comprising at least one element, the element comprising a plurality capsules disposed substantially in a single layer on a substrate and associated with a binder, thereby to form a film, wherein at least a portion of the element has an optically active fraction of at least 70%.

96. An encapsulated electrophoretic element comprising a plurality of non-spherical capsules disposed substantially in a single layer on a substrate, thereby to form a film.

97. An encapsulated electrophoretic display comprising at least one element, the element comprising a plurality of non-spherical capsules disposed substantially in a single layer on a substrate, thereby to form a film.